

Claims

1. In a method of manufacturing styrene by dehydrogenation of ethylbenzene in the presence of steam at elevated temperatures in a reactor system containing a dehydrogenation catalyst, the improvement comprising the steps of:
 - (a) separating the unreacted ethylbenzene from the crude styrene by fractionation in an ethylbenzene-styrene fractionator carried out at an overhead pressure below about 200 mmHg in the presence of a polymerization inhibitor;
 - (b) condensing the ethylbenzene overhead vapor from the fractionator in an azeotropic vaporizer to provide heat for boiling a reactor feed consisting essentially of an azeotropic mixture of ethylbenzene and water; and,
 - (c) compressing the vaporized reactor feed, the overhead vapor from the fractionator, or both to obtain an azeotropic mixture of ethylbenzene and water at a suitable pressure for feeding to the reactor system.
2. A method according to claim 1, further wherein the ethylbenzene-styrene fractionator is operated at an overhead pressure of between about 50 – 170 mmHg.
3. A method according to claim 1, further wherein the azeotropic mixture is boiled at a pressure of between about 250 – 390 mmHg.
4. A method according to claim 1, further wherein the temperature difference between the condensing overhead vapor and the boiling azeotropic mixture of ethylbenzene and water in the azeotropic vaporizer is between about 15 – 25° C.

5. A method according to claim 1, further wherein the fraction of overhead ethylbenzene vapor condensed in the azeotropic vaporizer is between 0.30 and 1.0.
6. A method according to claim 1, further wherein the water in the azeotropic mixture is derived from process condensate.
7. A method according to claim 1, further wherein the molar ratio of water to ethylbenzene in the reactor feed is between about 4 and 12.
8. A method according to claim 1, further wherein the pressure at the inlet to the reactor system is between about 400 – 1100 mmHg.
9. A method according to claim 1, further wherein said dehydrogenation catalyst consists essentially of an iron oxide based dehydrogenation catalyst.
10. A method according to claim 1, further wherein said fractionation is carried out under vacuum.
11. A method according to claim 1 wherein step (c) comprises compressing only the vaporized reactor feed.
12. A method according to claim 1 wherein step (c) comprises compressing only the overhead vapor from the fractionator.

13. A method according to claim 1 wherein step (c) comprises compressing both the vaporized reactor feed and the overhead vapor from the fractionator.
14. In a method of dehydrogenation of an alkylaromatic compound in the presence of steam at elevated temperatures in a reactor system containing a dehydrogenation catalyst, the improvement comprising the steps of:
 - (a) separating unreacted alkylaromatic compound from the crude product by fractionation in a fractionator carried out at an overhead pressure below 200 mmHg in the presence of a polymerization inhibitor;
 - (b) condensing the overhead vapor from the fractionator to provide heat for boiling a reactor feed consisting essentially of an azeotropic mixture of the alkylaromatic compound and water; and,
 - (c) compressing the vaporized reactor feed, the overhead vapor from the fractionator, or both to obtain an azeotropic mixture of the alkylaromatic compound and water at a suitable pressure for feeding to the reactor system.
15. In an apparatus for manufacturing styrene by dehydrogenation of ethylbenzene in the presence of steam at elevated temperatures comprising: (a) a reactor system having an inlet and an outlet, and containing a dehydrogenation catalyst, to produce a reactor effluent stream from the reactor system outlet; (b) a fractionation column downstream from the reactor system outlet for processing a first portion of the reactor effluent stream to produce a fractionation overhead stream; (c) a condenser/vaporizer for condensing at least a portion of the fractionation overhead stream by vaporizing ethylbenzene reactor feed; and (d) a conduit for passing the vaporized ethylbenzene

- reactor feed from the condenser/vaporizer to the reactor system inlet; the improvement comprising: at least a compressor for compressing vapor passing between the fractionation column and the condenser, for compressing vapor passing between the condenser/vaporizer and the reaction system inlet, or both.
16. An apparatus according to claim 15 wherein a compressor is located in-line between the fractionation column and the condenser/vaporizer.
 17. An apparatus according to claim 15 wherein a compressor is located in-line between the condenser/vaporizer and the reaction system inlet.
 18. An apparatus according to claim 15 wherein a first compressor is located in-line between the fractionation column and the condenser/vaporizer and a second compressor is located in-line between the condenser/vaporizer and the reaction system inlet.
 19. An apparatus according to claim 15 wherein said fractionation overhead stream consists essentially of ethylbenzene.
 20. An apparatus according to claim 15 further wherein the ethylbenzene reactor feed used in condensing the fractionation overhead stream includes a second portion of the reactor effluent stream.
 21. An apparatus according to claim 15 further wherein the ethylbenzene reactor feed used in condensing the fractionation overhead stream includes a recycled portion of

the condensed fractionation overhead stream following additional downstream processing.

22. An apparatus according to claim 15 further wherein the ethylbenzene reactor feed used in condensing the fractionation overhead stream includes a second portion of the reactor effluent stream and a recycled portion of the condensed fractionation overhead stream following additional downstream processing.